Measurement of the Intracranial Arterial Wedge Pressure in Cases of Acute Cerebral Arterial Occlusion to Determine the Indication of Intraarterial Thrombolytic Therapy

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Summary

Wedge pressure of the occluded major cerebral artery (distal pressure beyond the occlusion) was measured to estimate the residual cerebral blood flow in thirteen patients with acute ischemic stroke. There existed the relationship that patients with higher wedge pressure tolerated longer ischemic insults than those with lower wedge pressure. Wedge pressure is measured with minimum time loss before starting thrombolytic therapy and may be a good indicator to estimate the brain tissue reversibility.

Introduction

To establish the indication of the intra-arterial thrombolytic therapy of the acute ischemic stroke [1-3] with minimum time loss, wedge pressure of the occluded major cerebral artery (distal pressure beyond the occlusion), which might be a possible indicator of residual cerebral blood flow, was measured.

Patients and Methods

Wedge pressure was measured in thirteen patients with acute ischemic stroke of internal carotid or middle cerebral arterial occlusion, who were treated with superselective thrombolytic therapy within 6 hours from the onset except one case with fluctuating symptom (table 1). A microcatheter was navigated beyond the clot via transfemoral route and connected to the pressure transducer to monitor wedge pressure. Patients had 10 MCA or MCA branch occlusion, and 3 intracranial ICA occlusion. They were treated with superselective tPA or urokinase infusion or percutaneous transluminal angioplasty [4].

Results

Wedge pressure varied from 26 mmHg to 66 mmHg in each case. Patients with higher wedge pressure had lower NIHSS score, while those with lower wedge pressure had higher NIHSS score with statistical significance ($p< 0.05$). Also, patients with ICA occlusion showed lower wedge pressure than those with MCA or MCA branch occlusion. From our data, patients with higher wedge pressure tolerated longer ischemic insults than those with lower wedge pressure (figure 1). Also, patients with higher wedge pressure were tend to have lower rate of hemorrhagic complication and good outcome.

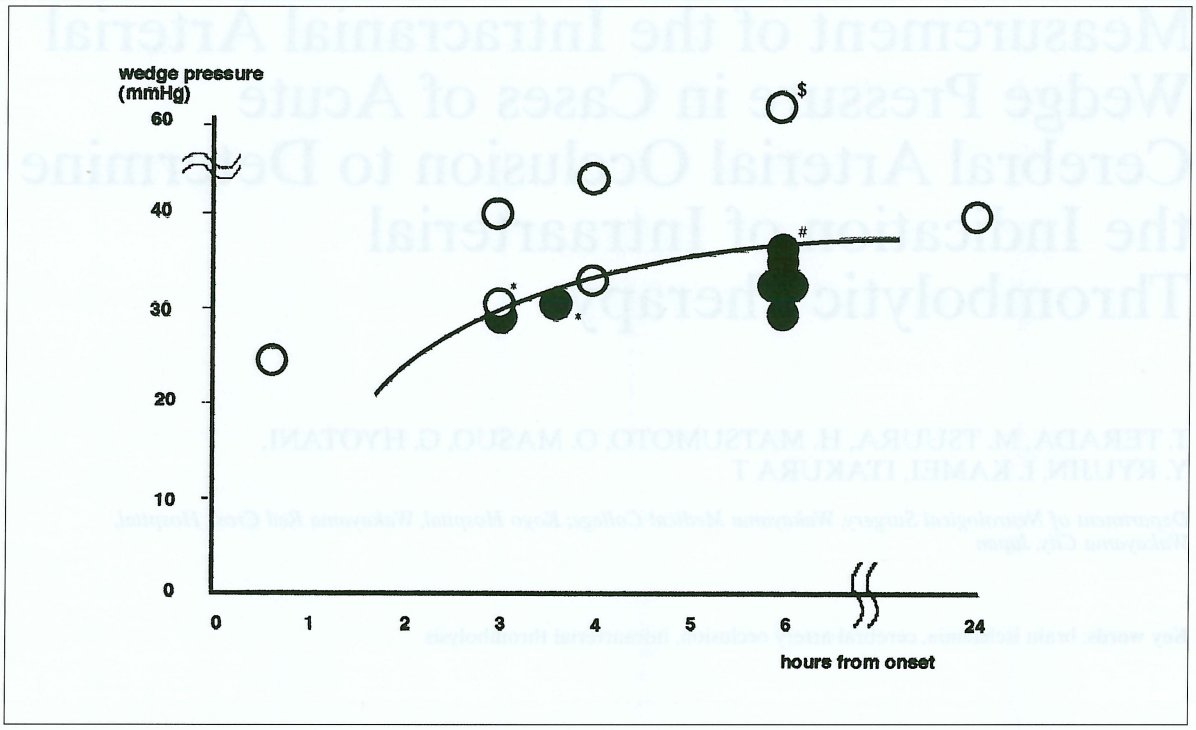

Figure 1 Relationship between the duration of ischemia and wedge pressure. Open circles show cases without cerebral infarction greater than 2 cm in diameter. Closed circles show cases which caused cerebral infarction greater than 2 cm in diameter in spite of recanalization. The cases located under the curve were supposed to cause cerebral infarction in spite of recanalization. * reveals case 10; different arterial branches were opened at different time (3 hr and 3.5 hr), therefore two circles were plotted in one case. §§ reveals case 12; The occluded artery was not recanalized but cortex was kept intact without difinite low density. # reveals case 8; The occluded artery was not recanalized and early ischemic signs were not demonstrated on CT. This case can not be judged whether tolerated ischemia or not.

Discussion

In our series, the critical wedge pressure that causes neurological deficit without cellular damage (at the state of penumbra) was judged nearly 40 mmHg from case 5. In this case neurological symptoms were fluctuating depending on the systemic blood pressure and the M1 was recanalized nearly 24 hours from the onset without low density area in the cortex. In the other two cases whose wedge pressures were greater than 40 mmHg (48 mmHg, 66 mmHg), their neurological symptoms mainly derived from the ischemia of the territory of perforating artery of the MCA. In these two cases, almost the entire cortex was kept intact in spite of the recanalization of the major arteries, although low density area appeared in basal ganglia. Therefore, if the wedge pressure is higher than 40 mmHg, the brain tissue may tolerate more than 6 hours ischemia. Ueda et Al[5] reported three cases with enough residual blood flow resulting in non-infarction, although these cases were recanalized between 6 and 12 hours from the onset. In our series, patients with higher wedge pressure tolerate longer ischemic insults than those with lower wedge pressure. Similar relationship as shown between CBF and duration of tolerable ischemia was found between wedge pressure and duration of ischemia (figure 1). Furthermore, IC top occlusion cases, which have poorer collateral circulation than MCA occlusions, demonstrated smaller wedge pressure than that of the MCA occlusion group. The group with wedge pressure greater than 40 mmHg had a better NIHSS score than the group with the lower wedge pressure. As for the wedge pressure and the outcome, the group with the higher wedge pressure had a tendency to have better outcomes without statistical significance. It seems difficult to predict prognosis only from the values of wedge pressure, because there exist other parameters such as recanalization and the

Table 1 **Profile of cases**

No.	Age / Sex	E / T	Site	Duration	Recanal	WP / SP	CT	Method	NIHSS	Rankin
1*	64 / F	E	lt-M1	6 hr	–	33 / 95	+ H	tPA, PTA	16	died
2	52 / F	E	lt-M1	4 hr	+	33 / 103	+–	tPA	24	1
3	58 / M	E	lt-M2	3 hr	+	40 / 92	–	tPA, PTA	16	1
4	78 / M	E	lt-IC	6 hr	partial	30 / 105	+ H	UK	16	4
5	56 / M	E	rt-M1	24 hr	+	40 / 92	–	tPA	8	1
6	60 / M	E	rt-M1, A2	6 hr	partial	33 / 145	+ H	tPA, PTA	17	died
7	77 / M	E	rt-IC	6 hr	–	33 / 116	+ H	tPA	20	died
8	54 / F	E	lt-M1	6 hr	–	37 / 113	?	UK	16	died
9	67 / M	T	lt-ICtop	30 min	+	26 / 117	–	PTA	15	1
10†	60 / F	E	lt-M1, M2, A3	3 hr	+	30 / 100	–	tPA, PTA	16	3
			lt-M2	3.5 hr	+	30 / 100	+	tPA		
11	70 / F	E	rt-IC	3 hr	–	30 / 96	+ H	UK	16	died
12‡	70 / F	E	lt-M1	6 hr	–	66 / 105	–	tPA	14	3
13	41 / M	E	lt-M1	4 hr	+	48 / 95	–	tPA	8	1

*E = embolism; T = thrombosis; recanal = recanalization; WP = mean wedge pressure; SP = systemic mean arterial pressure (mmHg); CT = CT findings; H = hemorrhage; F = female; M = male; rt = right; lt = left; M = middle cerebral artery; A, anterior cerebral artery; IC = internal carotid artery; hr = hour; tPA = tissue plasminogen activator; UK = urokinase; PTA = percutaneous transluminal angioplasty. + in the column of CT means the appearance of low density area greater than 2 cm in diameter or early ischemic signs on CT. – means no low density area or appearance of density area smaller than 2 cm in diameter on CT. ? in case 8 means that this case can not be judged whether tolerates the ischemia or not because of non recanalization and lack of early ischmic sign when the procedure finished. – in the column of recanalization means TIMI grade 0,1. partial in the column of recanalization means TIMI grade 2. + in the column of recanalization means TIMI grade 3. * = Subarachnoid hemorrhage occurred related to interventional procedure (vessel perforation by guidewire). † = MCA posterior branch was recanalized at 3 hr without infarction but anterior branch was recanalized at 3.5 hr and resulted in infarction on CT. ‡ = The proximal M1 was occluded. Recanalization failed and resulted in an infarction in basal ganglia but the entire cortex was free from infarction.*

duration of ischemia. From these data, wedge pressure seems to reflect the residual cerebral blood flow, although our data is preliminary and number of patients is limited.

Conclusions

Arterial wedge pressure distal to the clot may be a good indicator of residual cerebral blood flow and be useful to determine the indication of thrombolytic therapy in just a few minutes of time.

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